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Apparatus for reading/writing multilayer optical disc with improved layer jump

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APPARATUS FOR READING/WRITING MULTILAYER OPTICAL DISC WITH IMPROVED LAYER JUMP

The present invention relates to a driving apparatus for an optical pickup head. More particularly, the invention relates to a method and a unit for controlling the motion of an objective lens along a focus direction to perform a jump of the laser focus point from a first layer to a second layer of a multilayer disc.

The need for storage medium with high capacity has led to optical discs having a plurality of data layers, such as DVDs.

The optical disc is rotated by a spindle motor, and an optical pickup head placed on a sled is driven radially from the centre to the periphery of the disc. The optical pickup head can reach the desired position for reading data localised, on the disc layer, along a spiral track.

The optical pickup head emits a light beam along an optical axis substantially perpendicular to the disc. The light beam converges in a focus point which must be placed in the middle of the track to be read.

It is well-known to use error signals to correct in real time the position of the focus point in order to place it precisely in the middle of the track. A focus error signal is used to automatically perform focus adjustment along the optical axis which is also called the focusing direction.

During reading of such a multilayer disc, it is necessary to swap from a first layer to a second or target layer through a so-called jump. The light is focused by a mobile lens at the focus point. The jump consists in moving the lens rapidly so that the focus point moves from the first to the second layer.

The jump can not be performed by simply focusing the light beam at a predefined remote distance equal to the pitch between the first and second layers, because during the jump the distance relative to the disc, along which the lens has to be moved, is not known, due to the own motion of the disc along the optical axis.

US 2001/0030916 discloses layer jump control method and apparatus for jumping accurately and rapidly on a target layer. When a jump order is issued, a kick pulse followed by a brake pulse is applied on the focus drive unit of the lens in order

to move it along the focusing direction from a first position, corresponding to the zero central value of the focus error signal relative to the first layer, until a second position is reached. This second position corresponds to the zero value of the focus error signal relative to the second layer. The method disclosed in this document is characterised by setting the operation voltage of the focalising lens of the pickup head and adjusting the kick pulse time and brake pulse time.

In this method, it is as if the jump control unit looked for the second layer by moving the optical pickup head along the focusing direction.

The reasons why a jump performed with a predetermined distance (equal to the pitch D between the two layers) may fail are not analysed and are not taken into account in this document.

It is an object of the present invention to propose an improved way of performing a jump from a first layer to a second layer of a multilayer optical disc.

The invention provides a method for controlling the motion of an objective lens when performing a jump of a focus point of a light beam, focused by the objective lens, along a focusing direction from a first layer to a second layer of a multilayer optical disc, comprising the steps of, when a jump order is issued:

- moving said objective lens relative to a static reference along said focusing direction towards the second layer according to a set of cinematic parameters ;
- monitoring, during the motion, a focus error signal correlated with the shift between the focus point and the first layer;
- measuring a time period between a first characteristic value and a second characteristic value of said focus error signal; and,
- when the second characteristic value is detected, adjusting said set of cinematic parameters depending on said time period to overcome the effects of the disc motion relative to said static reference;
- moving further said objective lens towards the second layer according to the set of adjusted cinematic parameters.

The invention is based on the recognition that when jumping from a first to a second layer of the disc, an error is made on the position of the second layer mainly because of the disc skew and the wobble the motor that is responsible for rotating the disc (the disc skew is a local or global deviation of the substrate thickness of the disc

from the standard thickness of the substrate, due to manufacturing process of the disc). The error that is made on the position of the target layer leads to inaccuracy in the position of the focus point.

With the invention the effects of the motion of the disc itself relative to the static reference (whatever its origin: disc skew, wobble of the motor or any other reason) are compensated for when determining the cinematic parameters to be used for performing the jump.

More specifically, this compensation is achieved by monitoring the focus error signal during the motion of the lens.

Therefore the invention provides for a simple an efficient way of improving the robustness of the layer jump.

In a preferred embodiment, the adjusting step comprises a step of calculating an instant acceleration of the disc relative to said static reference depending on said time period, the set of cinematic parameters being adjusted depending on said instant acceleration of the disc.

Preferably, for the adjustment of the set of cinematic parameters, the acceleration of the disc relative to said static reference is considered to be constant throughout the completion of the jump.

In a first alternative, the set of cinematic parameters comprises kick and brake accelerations of the objective lens along the focusing direction relative to said static reference, and kick and brake periods of time during which the objective lens is successively moved at the kick acceleration and at the brake acceleration respectively, the adjusting step consisting in determining an adjusted value for at least one of said kick and brake accelerations, said kick and brake periods of time being fixed.

In a second alternative, the set of cinematic parameters comprises kick and brake accelerations of the objective lens along the focusing direction relative to said static reference, and kick and brake periods of time during which the objective lens is successively moved at the kick acceleration and at the brake acceleration respectively, the adjusting step consisting in determining a adjusted value for at least one of said kick and brake periods of time, said kick and brake accelerations being fixed.

The invention also provides with a circuit intended to cooperate with an optical pickup head that comprises an objective lens for focussing a light beam at a focus point, said circuit comprising,

- means for moving the objective lens, relative to a static reference, along a focusing direction from a first layer of a multilayer optical disc towards a second layer of said disc according to a set of cinematic parameters;
- means for monitoring, during the motion of the objective lens, a focus error signal correlated with the shift between the focus point and the first layer;
- means for measuring a time period elapsed between a first characteristic value and a second characteristic value of said focus error signal; and,
- means for adjusting said set of cinematic parameters, when said second characteristic value is reached, depending on said time period, to overcome the effects of the disc motion relative to said static reference.

The invention further provides with a multilayer optical disc reading and/or writing apparatus comprising:

- an objective lens for focussing a light beam at a focus point;
- means for moving the objective lens, relative to a static reference, along a focusing direction from a first layer of a multilayer optical disc towards a second layer of said disc according to a set of cinematic parameters;
- means for monitoring, during the motion of the objective lens, a focus error signal correlated with the shift between the focus point and the first layer;
- means for measuring a time period elapsed between a first characteristic value and a second characteristic value of said focus error signal; and,
- means for adjusting said set of cinematic parameters, when said second characteristic value is reached, depending on said time period, to overcome the effects of the disc motion relative to said static reference.

In a preferred embodiment, said adjusting means comprise means for calculating a disc acceleration relative to said static reference depending on said time period, the set of cinematic parameters being adjusted depending on said instant acceleration of the disc.

The invention will be better understood and its other aims, details features and advantages will be clearly shown with reference to the following description of a

particular embodiment of the invention, given only for illustrative and not limitative purposes, in connection with the accompanying drawings, in which:

- figure 1 is a schematic diagram of a multi-layer disc reading / writing apparatus;
- figure 2 shows a detail view of the pickup head of figure 1;
- figure 3 shows the principle of generation of the focus error signal ;
- figure 4 is a graph of the amplitude of the focus error signal versus shift between the focal plane and the data layer to be read ;
- figure 5 is a bloc diagram of the preferred embodiment of the method according to the invention ;
- figures 6A-6C are time evolution of a plurality of variables during the jump.

Figure 1 shows a schematic representation of an apparatus for reading/writing data from/onto a multi-layer disc 1.

The apparatus shown in figure 1 comprises inter alias:

- an optical pickup head 2 comprising amongst other elements an objective lens 6 and a light emitting laser diode 3;
- a signal pre-processing circuit 21 for pre-processing the signal delivered by the optical pickup head 2,
- a unit 30 for controlling the motion of the objective lens 6,
- a spindle motor 20 having a rotor and a stator for rotating the disc 1,
- a rotation control circuit 26 for controlling the rotation of the motor 20,
- a microprocessor 27 for controlling the operation of the apparatus,
- a bus 28 for transporting control signals,
- a source encoder/decoder 32,
- a channel encoder 33,
- a channel decoder 34,
- a unit 38 for controlling the light emitting laser diode 3; and
- a host system 40 (by way of example the host system 36 can be a personal computer, an audio player, a video player...).

The rotation control circuit 26, the objective lens control unit 30 , the source encoder/decoder 32, the channel decoder 34, the channel encoder 33, the light emitting diode control unit 38 and the microprocessor 27 are connected to the bus 28.

The unit 30 receives the signal read by the optical pickup head 2 and generates a data signal D, a tracking error signal TE and a focus error signal FE.

The data signal D is input to the channel decoder 34. The signal delivered by the channel decoder 34 is forwarded to the source coder /decoder 32 for decoding. Eventually, the resulting decoded signal D_OUT is delivered to the host system 40.

The tracking error signal TE and the focus error signal FE are delivered to the unit 30. They are used for controlling the motion of the objective lens 6 in a way that will described below by reference to figures 2 to 6.

In writing mode, the host system 40 provides input data D_IN to the source encoder/decoder 32 for source encoding. The source encoded data are then forwarded to the channel encoder 33 for channel encoding. The channel encoded data are used to control the unit 38 for writing on the disc 1.

Advantageously, the blocks carrying references 21 to 38 in figure 1 are implemented in the form of one or more semiconductor circuits.

As shown in figure 1, the disc 1 has a top face 1a usually covered by a label and a bottom face 1b oriented toward a pickup head 2. The disc has a first data layer L1 and a second data layer L2. The first layer L1 is closer to the optical head 2 than the second layer L2. On each layer, data are written along a spiral track.

The disc 1 is rotated by the rotor of a spindle motor 20. The stator of the spindle motor 20 is fixed relative to the casing of the apparatus. Hereafter, the stator is used as static reference for motions. Other static references could be used.

The optical pickup head 2 is represented in more detail in figure 2. The pickup head 2 comprises a light emitting laser diode 3, a polarizing beam splitter 4, a collimating lens 5 and an objective lens 6. The light is incident on the disc along an optical axis Z which is substantially perpendicular to the disc 1. The light beam is focused in a focus point P by the objective lens 6. The plane perpendicular to the optical axis Z in the focus point is called the focus plane F.

The reflected light from the disc passes back through the objective lens 6, the collimating lens 5 and the beam splitter 4. Due to its different polarization, le reflected light is reflected towards a detection unit 7 through a cylindrical lens 8.

It is of primary importance for an optical system to keep the focus point P in the middle of a track. Together with a track error signal used to automatically

perform radial tracking along a direction parallel to the disc, a focus error signal (FE signal) is used to automatically perform focus adjustment along the optical axis Z perpendicular to the disc. The optical axis Z is also called the focusing direction. These error signals are used as regulation variable in regulation loops.

More precisely, the FE signal can be determined as soon as there is an asymmetry in the optical path. The most widely used method for obtaining a FE signal consists in deliberately introducing an optical aberration called astigmatism by means of the cylindrical lens 8 provided along the reflected light path just before the detection unit 7.

Referring now to figure 3, behind the cylindrical lens 8, the transverse section shape of the reflected light beam is an ellipse. The elongation of this ellipse is a function of the shift distance Δz between the focus plane F and the data layer L to be read. The elliptical reflected light beam is detected by an assembly comprising four photodetectors 9a, 9b, 9c and 9d. The FE signal is simply given by: $S = (V_a + V_c) - (V_b + V_d)$, where V_i is the potential between the terminals of the i^{th} photodetector. If the focus plane F is nearer the objective lens 6 than the data layer L, the elliptical beam illuminates predominantly photodetectors 9b and 9d. The value of the FE signal is therefore a negative voltage. If the focus plane F is too far, the elliptical beam illuminates predominantly photodetectors 9a and 9c. The value of the FE signal is therefore positive. If the focus plane F is in focus on the data layer L, the transverse section of the reflected light beam becomes a circle and all the photodetectors are equally illuminated. Thus the value of the FE signal is zero.

Figure 4 is a graph showing the FE signal as a function of the shift Δz between the focus plane F and the data layer L. It is to be noted that this S curve has a high peak P+ and a low peak P- which correspond respectively to maximum and minimum values of the FE signal. P+, P- and 0 are characteristic values of the FE signal. When the FE signal is zero, the focus point P is on the layer L. When FE signal is P+ or P-, the shift Δz is equal to a predefined value, for example: $\Delta z_{p+} = \Delta z_{p-} = 4\ \mu m$.

Referring back to figure 2, the objective lens 6 is supported, via an objective bearing 10, by a plurality of springs 11 so that the objective lens 6 can be moved in a

focusing direction and in a tracking direction, i.e. axially and radially relative to the optical direction Z.

The bearing 10 is provided with a coil 12 which is lying in the middle of a permanent magnet 13. When a driven signal is applied to the coil 12 by a driving circuit 22 (figure 1), a driving force parallel to the focusing direction is generated and is able to move the objective lens towards and backwards the disc as indicated by the arrow.

The objective lens moving control unit, shown in figure 1, will now be described in detail. This unit comprises a signal processing unit 21, a driving circuit 22, a tracking control unit 23, a focus control circuit 24, a layer jump control circuit 25, a rotation control circuit 26 and a controller 27.

The optical disc 1 is rotated by the spindle motor 20. The disc rotation frequency is adapted according to the portion of the disc which is being read. It's the reason why the spindle motor 20 is controlled by a rotation frequency control signal emitted by the rotation control circuit 26.

As shown before, the reflected light allows to build a focus error signal and a tracking error signal which are generated as output of the signal processing circuit 21. The FE signal is inputted into the focus control circuit 24 which regulates the position of the objective lens along the focusing direction via the driving circuit 22. The tracking error signal is inputted into the tracking control circuit 23 which regulates, via the driving circuit 22, the position of the objective lens radially relative to the track to be read.

When a jump order is issued by the controller 27, the tracking and focus control circuit are turned off and the layer jump control circuit 25 is turned on for managing the jump operation in coordination with the controller 27. The jump control circuit emits as output a driving signal to the driving circuit 22, which, in response, applies a jump pulse intensity on the objective lens actuator to perform the jump of the focus point from the first layer to the second layer.

Because the motion of the focus point relative to the disc is the combination of the disc own motion relative to the stator and the motion of the objective lens relative to the stator, the method according to the invention consists in measuring the acceleration of the disc relative to the stator along the optical direction Z and to

compensate this disc acceleration by adjusting accordingly the cinematic parameters of the jump and consequently the instant jump pulse intensity applied on the lens actuator.

Usually, the jump along the focusing direction is performed first by accelerating the objective lens with a constant kick acceleration a_{acc} and then by decelerating it with a constant brake acceleration a_{brake}. In the preferred embodiment, the kick acceleration and the brake acceleration have the same absolute value. The kick period of time during which the objective lens is accelerated at the kick acceleration is equal to the brake period of time during which the objective lens is decelerated at the brake acceleration. In this case, the braking step occurs when the objective lens is at half the pitch D between the two layers, and the kick period is equal to the brake period (T).

At the end of the jump operation, the variation Δz of the position of the focus point relative to the stator is:

$$\Delta z = \frac{1}{2} a_{acc} T^2 + \frac{1}{2} a_{brake} T^2$$

Besides, the position of the disc z_{disc} along the focusing axis relative to the stator due to extra displacement may be modelled by a periodical sinus function:

$$z_{disc} = A \sin(\omega_{rot} t)$$

where A is the amplitude of the displacement such as skew of the disc or wobble of the spindle motor, and ω_{rot} is the disc rotational speed.

The acceleration of the disc relative to the stator of the spindle motor a_{disc} can be obtained by two successive time derivation leading to :

$$a_{disc} = A \omega^2_{rot} \sin(\omega_{rot} t)$$

The jump duration 2T is sufficiently short to make the assumption that the acceleration of the disc is constant throughout the completion of the jump. Thus, after 2T, the displacement of the disc relative to the stator is:

$$z_{disc}(2T) = \frac{1}{2} a_{disc} (2T)^2$$

For example, with a rotational frequency of 55 Hz and an amplitude A of 1 mm, the maximum acceleration a_{disc} will be of 119 ms-2. The value z_{disc} will be equal to 59.5 µm which is greater than the typical 55 µm pitch D between the two layers. Through this numerical application, we can see that the compensation of the disc

displacement relative to the stator during the motion of the objective lens relative to the stator is essential for achieving a reliable jump process.

During the first step of the jump when the objective lens is accelerated relative to the stator, the displacement of the focus point relative to the disc at a given time is :

$$z = ½\, a_{acc}\, t^2 - ½\, a_{disc}\, t^2$$

On the S curve, the distance between the zero value and one of the peak values $P^{+/-}$ is a characteristic predefined distance dependent on the optical pick up head being used. In example shown in Figure 4, this characteristic predefined distance is $z_P = 4\ \mu m$.

Thus, measurement of the period of time Δt required to reach the peak from the first layer (focus point on the first layer), allows to know the instant value of the disc acceleration a_{disc}:

$$z_P = ½\, a_{acc}\, \Delta t^2 - ½\, a_{disc}\, \Delta t^2 \qquad (1)$$

Once this information has been retrieved, it is easy to adjust the jump pulse intensity i.e. the values of a_{acc} and/or a_{brake} to compensate the disc acceleration a_{disc}.

Figure 5 shows a diagram bloc of the method according to the invention using the above principle. This method can be implemented by processing the instructions of a software memorised in a memory space of controller 27.

In step 50, controller 27 checks if whether or not a jump order has been issued. If a jump order is request, the tracking and focus error control circuit are switched off at step 51.

It is assumed that at this initial instant the focus point is on the first layer, i.e. that the value of the FE signal is zero. A time variable t is set to zero.

The jump control circuit 25 is switched on. It reads the value of the kick acceleration a_{acc} in one of its memory buffer and requests the drive unit 22 to move the lens up with this constant acceleration (step 52).

During this motion, via step 53 of FE signal acquisition, the absolute value of the FE signal is monitored in step 54. If the instant absolute value of the FE signal is greater than the previous absolute value, the loop 55 is closed so that the motion of the lens goes on. The value of the time variable t is increased of a predetermined amount of time τ corresponding to the sampling period.

If the instant absolute value of the FE signal is smaller than the previous absolute value, processing goes out of loop 55, since it has been detected that the S curve has just reached its peak value.

For example, jump control circuit 25 monitors the FE signal and send a peak flag to the controller 27 when the peak of the FE signal has just been detected. The controller 27 then stops measuring the period of time between the beginning of the jump (FE signal equal to zero) and the peak detection, and processes the next steps.

In step 56, the value of the time variable t_1 is injected as Δt into equation (1) in order to calculate the instant disc acceleration a_{disc} which is written in the memory space of the controller 27.

The method goes on with step 57 where the value of kick and brake accelerations are modified: a new value for the kick acceleration and the brake acceleration is determined according to the instant disc acceleration. This new lens accelerations must overcome the effect of the dick own motion so that the jump operation is executed over a predetermined distance equal to the pitch D between the layers. For example, the new kick acceleration is equal to the kick acceleration minus the disc acceleration and the new brake acceleration is equal to the brake acceleration minus the disc acceleration. It is to be noted that the disc acceleration can be positive or negative.

These adjusted values of the lens accelerations are sent to the jump control circuit 25 in order to move the lens according to these new cinematic parameters (step 58) from t_1 to 2T. For example, controller 27 writes the adjusted value of the kick acceleration a_{acc} in a predefined memory buffer of the jump control circuit 25.

At time 2T, the jump is completed and the focus point is near the second layer. Tracking and focusing control circuits are switch on 59 and allow to read the track on the second layer.

Several time varying variables are shown in figures 6. At t=0, the jump order is issued and the motion of the lens is performed at the kick acceleration (Figure 6B). The focus point P moves up (figure 6C) out of the first layer. The value of the FE signal is no more zero (figure 6A). The FE signal value is monitored, and when the peak P- is reached, the disc acceleration is calculated leading to an update of the kick and brake accelerations. These modified values of the lens accelerations are

immediately used to adjust the motion of the lens. On figure 6B, dash lines represent correction of the kick and brake acceleration. At the end of the jump (t=2), the focus point has been moved relatively to the disc of a distance along the focusing direction equal to the pitch D between the two layers.

In another embodiment, the kick and brake period of time could be adjusted in order to overcome the effects of the disc acceleration, rather than the kick and brake accelerations.

It is to be noted that figure 5 has been described as a succession of steps, but could have been described as a plurality of means, for example program modules of a software, which are successively processed to implement the method according to the invention.

The various embodiments described above are provided by way of illustration only and should not be construed to limit the invention. Those skilled in the art will readily recognise various modifications that can be made to these embodiments without departing from the scope of the present invention, which is set in the following claims.

In particular the apparatus described by reference to figure 1 is capable of reading and writing data from/onto a multi-layer disc. However the invention also covers apparatus that are only capable of reading data or writing data from or onto a multi-layer disc.

The use of the verb "comprise" and its conjugation does not exclude the presence of other elements or steps than those listed in the claims or in the description.

The use of the article "a" or "an" for designating an element or a step in the claims or in the description does not exclude the presence of a plurality of such element or step.

CLAIMS

1. A method of controlling the motion of an objective lens when performing a jump of the focus point (P) of a light beam, focused by the objective lens (6), along a focusing direction (Z) from a first layer (L1) to a second layer (L2) of a multilayer optical disc (1), comprising the steps of, when a jump order is issued:
- moving (52) said objective lens relative to a static reference along said focusing direction towards the second layer according to a set of cinematic parameters ;
- monitoring (54), during the motion, a focus error signal (FE) correlated with the shift (Δz) between the focus point and the first layer ;
- measuring a time period (Δt) between a first characteristic value and a second characteristic value of said focus error signal ; and,
- when the second characteristic value is detected, adjusting (56, 57) said set of cinematic parameters depending on said time period to overcome the effects of the disc motion relative to said static reference;
- moving further (58) said objective lens towards the second layer according to the set of adjusted cinematic parameters.

2. A method of controlling the motion of an objective lens as claimed in claim 1, wherein said adjusting step comprises a step of calculating (56) an instant acceleration (a_{disc}) of the disc (1) relative to said static reference depending on said time period (Δt), the set of cinematic parameters being adjusted depending on said instant acceleration of the disc.

3. A method of controlling the motion of an objective lens as claimed in claim 2, wherein for the adjustment of the set of cinematic parameters, the acceleration (a_{disc}) of the disc relative to said static reference is considered to be constant throughout the completion of the jump.

4. A method of controlling the motion of an objective lens as claimed in one of claims 1 or 2, wherein the set of cinematic parameters comprises kick (a_{acc}) and brake (a_{brake}) accelerations of the objective lens (6) along the focusing

direction (Z) relative to said stator, and kick and brake periods of time (T) during which the objective lens is successively moved at the kick acceleration and at the brake acceleration respectively, the adjusting step (57) consisting in determining an adjusted value for at least one of said kick and brake accelerations, said kick and brake periods of time being fixed.

5. A method of controlling the motion of an objective lens as claimed in one of claims 1 or 2, wherein the set of cinematic parameters comprises kick (a_{acc}) and brake (a_{brake}) accelerations of the objective lens (6) along the focusing direction (Z) relative to said static reference, and kick and brake periods of time (T) during which the objective lens is successively moved at the kick acceleration and at the brake acceleration respectively, the adjusting step (57) consisting in determining a adjusted value for at least one of said kick and brake periods of time, said kick and brake accelerations being fixed.

6. A circuit intended to cooperate with an optical pickup head (2) that comprises an objective lens (6) for focussing a light beam at a focus point (P), said circuit comprising,

- means (22) for moving the objective lens (6), relative to a static reference, along a focusing direction (Z) from a first layer of a multilayer optical disc towards a second layer of said disc according to a set of cinematic parameters;
- means (8, 21) for monitoring, during the motion of the objective lens, a focus error signal (FE) correlated with the shift (Δz) between the focus point (P) and the first layer;
- means (25) for measuring a time period (Δt) elapsed between a first characteristic value and a second characteristic value of said focus error signal; and,
- means (25) for adjusting said set of cinematic parameters, when said second characteristic value is reached, depending on said time period, to overcome the effects of the disc motion relative to said static reference.

7. A multilayer optical disc reading and/or writing apparatus comprising:

- an objective lens (6) for focussing a light beam at a focus point (P);
- means (22) for moving the objective lens (6), relative to a static reference, along a focusing direction (Z) from a first layer of a multilayer optical disc towards a second layer of said disc according to a set of cinematic parameters;
- means (8, 21) for monitoring, during the motion of the objective lens, a focus error signal (FE) correlated with the shift (Δz) between the focus point (P) and the first layer;
- means for measuring a time period (Δt) elapsed between a first characteristic value and a second characteristic value of said focus error signal; and,
- means for adjusting said set of cinematic parameters, when said second characteristic value is reached, depending on said time period, to overcome the effects of the disc motion relative to said static reference.

8. A multilayer optical disc reading and/or writing apparatus as claimed in claim 7, wherein said adjusting means comprise means for calculating a disc acceleration (a_{disc}) relative to said static reference depending on said time period (Δt), the set of cinematic parameters being adjusted depending on said instant acceleration of the disc.

9. A multilayer optical disc reading and/or writing apparatus as claimed in claim 8 wherein for the adjustment of the set of cinematic parameters, the acceleration (a_{disc}) of the disc relative to said static reference is considered to be constant throughout the completion of the jump.

10. A multilayer optical disc reading and/or writing apparatus as claimed in one of claims 7 or 8, wherein the set of cinematic parameters comprises kick (a_{acc}) and brake (a_{brake}) accelerations of the objective lens (6) along the focusing direction (Z) relative to said static reference, and kick and brake periods of time (T) during which the objective lens is successively moved at the kick acceleration and at the brake acceleration respectively, the adjusting step (57) consisting in determining an adjusted value for at least one of said kick and brake accelerations, said kick and brake periods of time being fixed.

11. A multilayer optical disc reading and/or writing apparatus as claimed in one of claims 7 or 8 wherein the set of cinematic parameters comprises kick (a_{acc}) and brake (a_{brake}) accelerations of the objective lens (6) along the focusing direction (Z) relative to said static reference, and kick and brake periods of time (T) during which the objective lens is successively moved at the kick acceleration and at the brake acceleration respectively, the adjusting step (57) consisting in determining a adjusted value for at least one of said kick and brake periods of time, said kick and brake accelerations being fixed.

ABSTRACT

APPARATUS FOR READING/WRITING MULTILAYER OPTICAL DISC WITH IMPROVED LAYER JUMP

The invention relates to a multilayer optical disc reading and/or writing apparatus comprising means for performing accurate jumps between layers of a multilayer optical disc.

To perform a jump, the objective lens is moved, relative to a static reference, along a focusing direction (Z) from a first layer towards a second layer of the disc according to a set of cinematic parameters.

According to the invention, a focus error signal (FE) correlated with the shift (Δz) between the focus point (P) and the first layer is monitored during the motion of the lens. The time period (Δt) elapsed between a first characteristic value and a second characteristic value of said focus error signal is determined, and the set of cinematic parameters is adjusted, when said second characteristic value is reached, depending on said time period, to overcome the effects of the disc motion relative to said static reference.

(Figure for the abstract : figure 6)

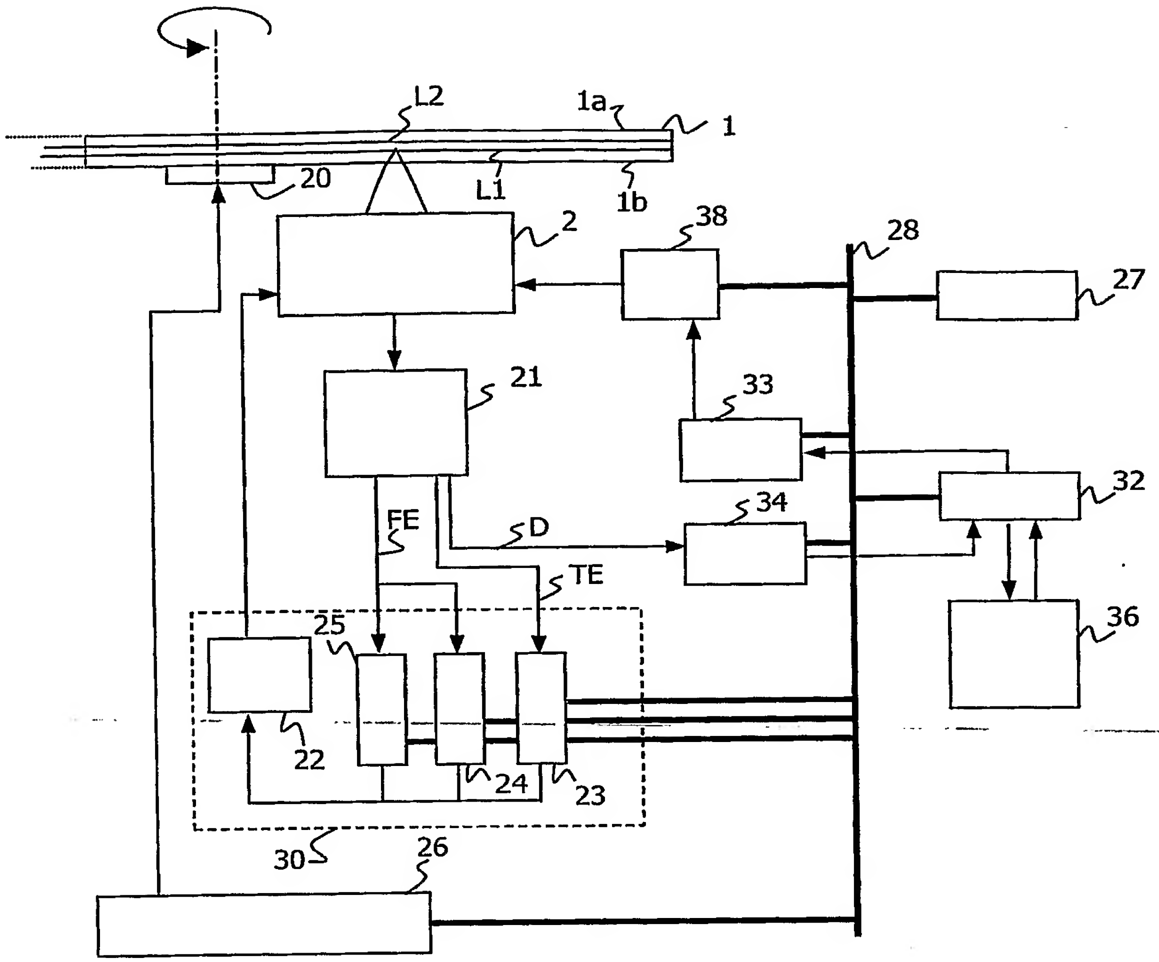


FIG.1

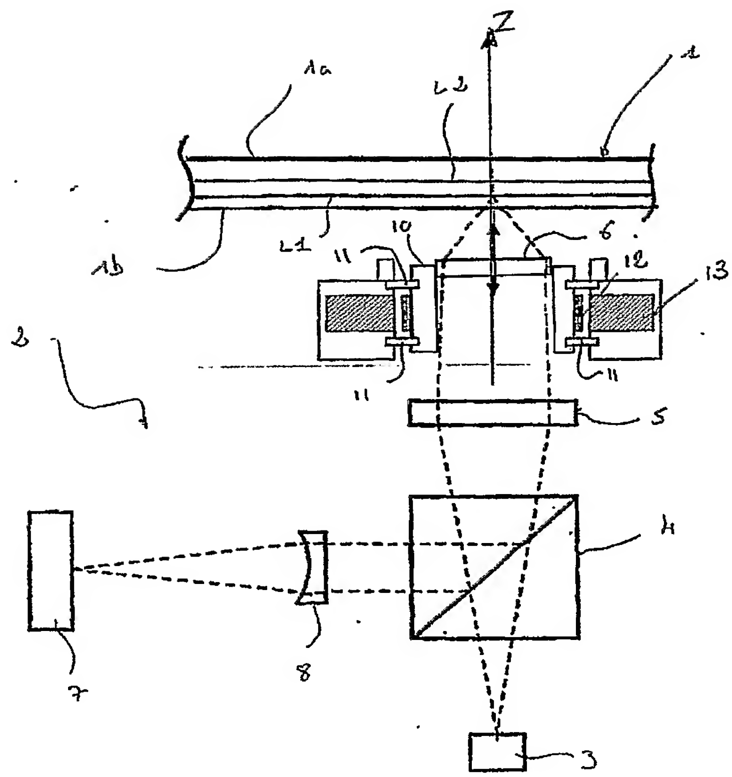


Fig 2.

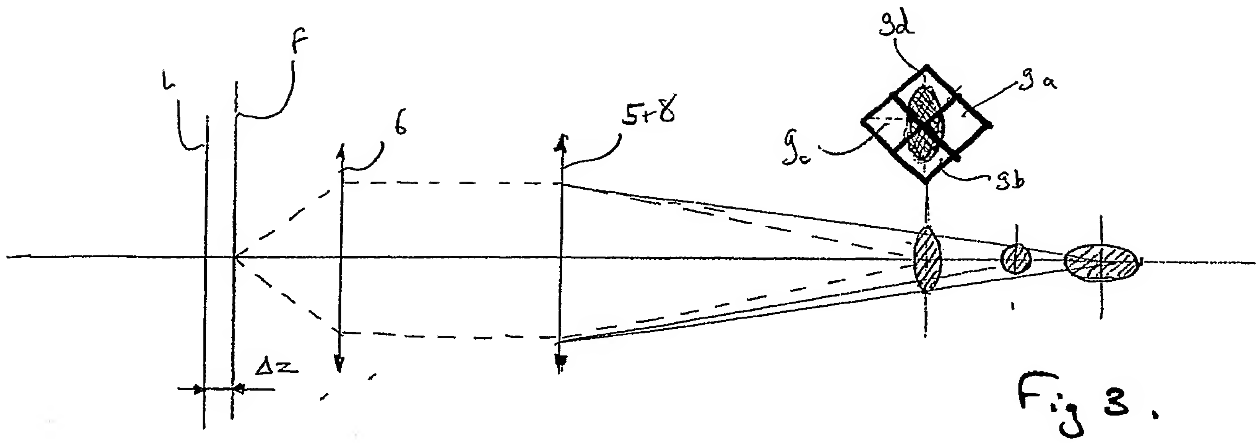


Fig 3.

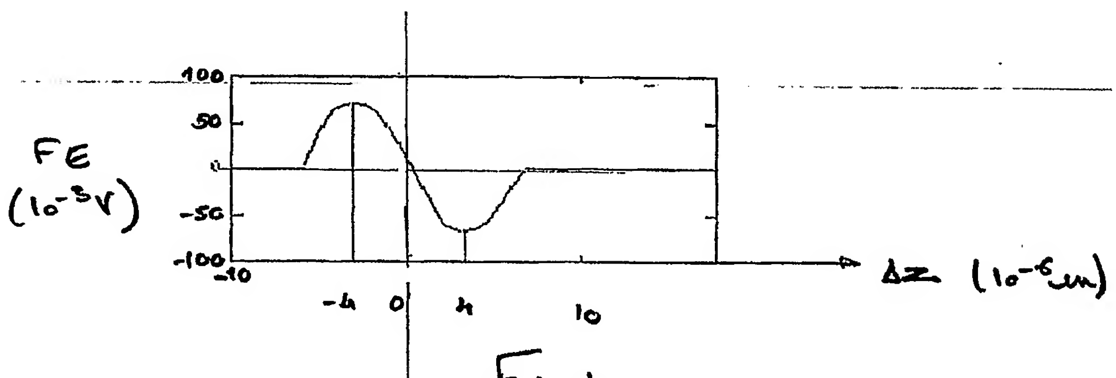


Fig 4.

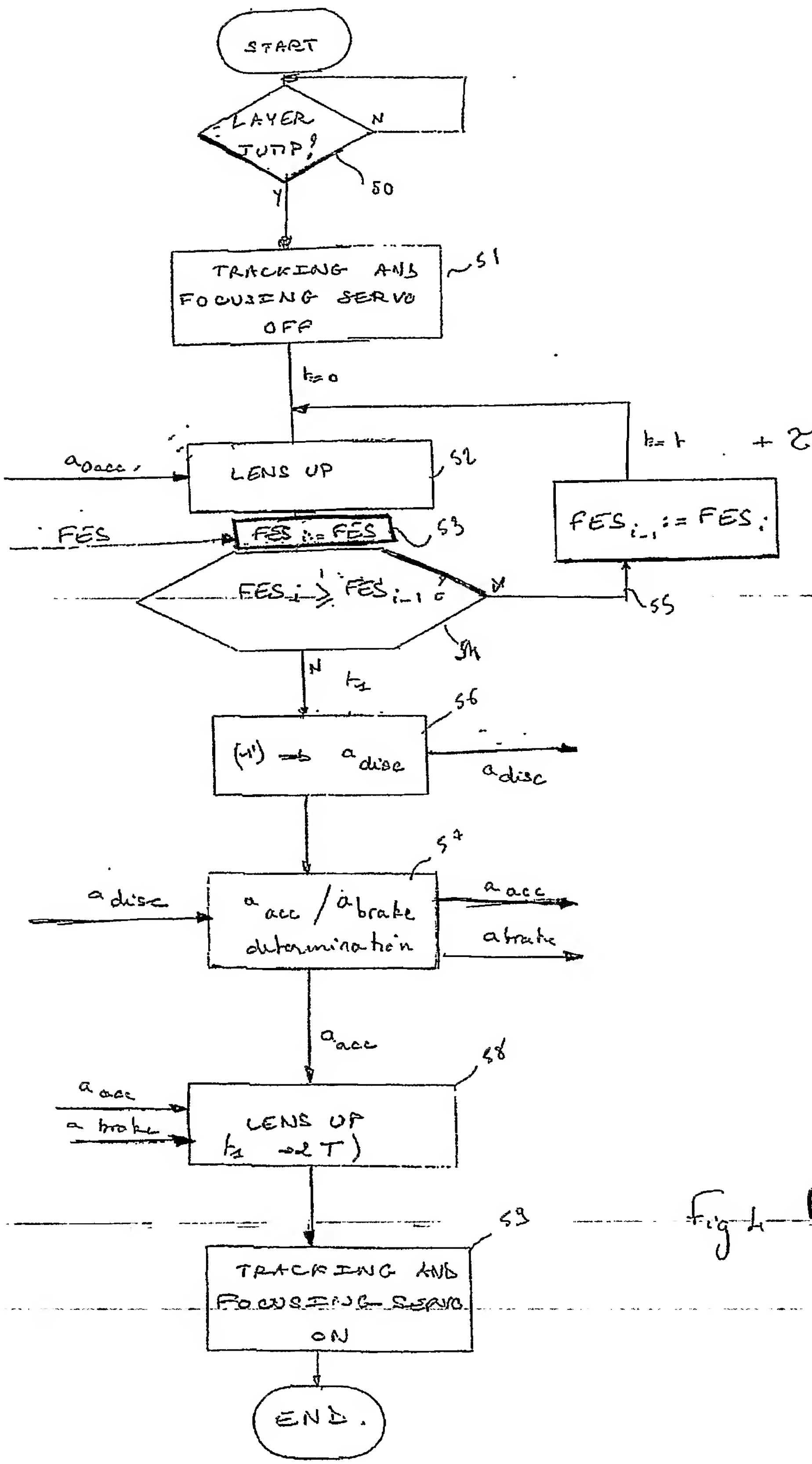
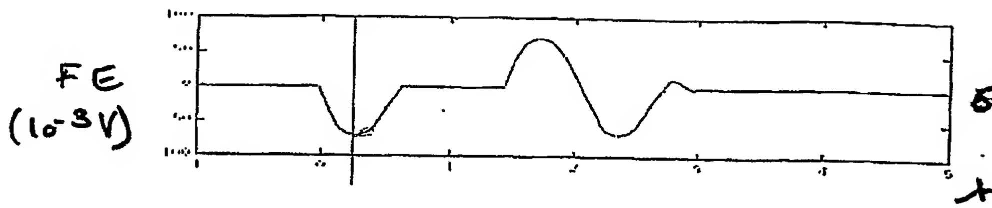
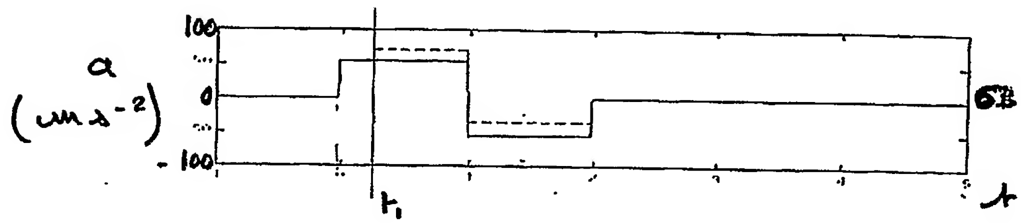

START
LAYER JUMP?
N
Y
50
TRACKING AND FOCUSING SERVO OFF
51
t=0
LENS UP
52
FES
FES i:= FES
53
FES i ≥ FES i-1
Y
N
55
FES i-1 := FES i
56
(-1) → a disc
a disc
57
a disc
a acc / a brake determination
a acc
a brake
a acc
58
a acc
a brake
LENS UP
59
TRACKING AND FOCUSING SERVO ON
END.

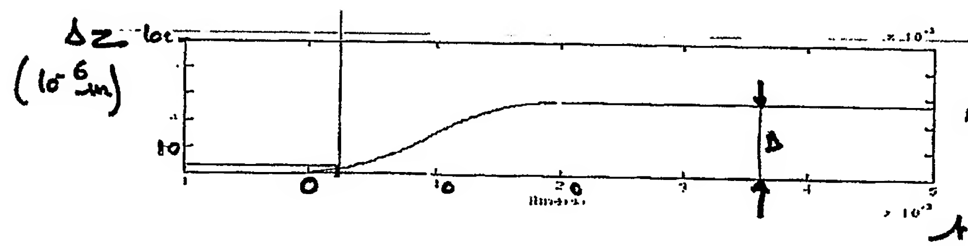
Fig 5.



5A



5B



5C.

PCT/IB2005/050677